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Space data and information transfer systems — Protocol specification for space communications — File protocol

*Systèmes de transfert des informations et données spatiales —
Spécification d'un protocole pour communications spatiales — Protocole de
classement*



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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 15894 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 717.0-B-1) and was adopted (without modifications except those stated in clause 3 of this International Standard) by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 13, *Space data and information transfer systems*.

Space data and information transfer systems — Protocol specification for space communications — File protocol

1 Scope

This International Standard specifies the requirements for the services and protocols of the space communications protocol specification (SCPS) file transfer service. These requirements are to allow independent implementations of this protocol in space and ground segments of the SCPS network to interoperate.

This International Standard addresses those considerations attending communications between space platforms and ground systems, and between space platforms.

2 Conformance

This International Standard is applicable to all systems that claim conformance to the ISO/CCSDS SCPS file protocol.

3 Requirements

Requirements are the technical recommendations made in the following publication (reproduced on the following pages), which is adopted as an International Standard:

CCSDS 717.0-B-1, May 1999, *Recommendation for space data system standards — Space communications protocol specification (SCPS) — File protocol (SCPS-FP)*.

For the purposes of international standardization, the modifications outlined below shall apply to the specific clauses and paragraphs of publication CCSDS 717.0-B-1.

Pages i to v

This part is information which is relevant to the CCSDS publication only.

Page 1-3

Add the following information to the references indicated in paragraph 1.6:

[3] Document CCSDS 102.0-B-4, November 1995, is equivalent to ISO 13419:1997.

[4] Document CCSDS 714.0-B-1, May 1999, is equivalent to ISO 15893:2000.

4 Revision of publication CCSDS 717.0-B-1

It has been agreed with the Consultative Committee for Space Data Systems that Subcommittee ISO/TC 20/SC 13 will be consulted in the event of any revision or amendment of publication CCSDS 717.0-B-1. To this end, NASA will act as a liaison body between CCSDS and ISO.

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Consultative Committee for Space Data Systems

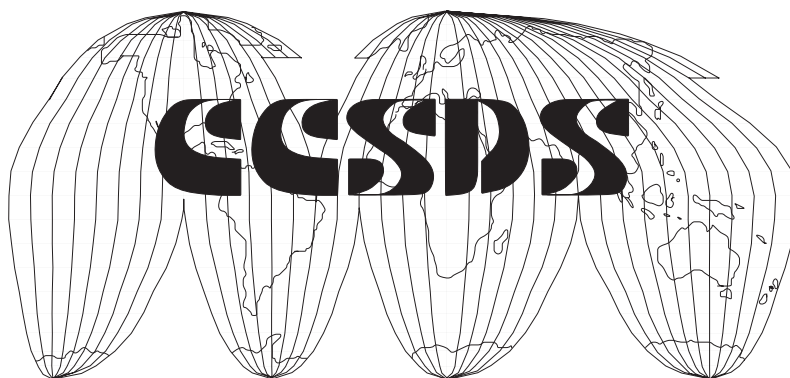
RECOMMENDATION FOR SPACE
DATA SYSTEM STANDARDS

SPACE COMMUNICATIONS PROTOCOL SPECIFICATION (SCPS)— FILE PROTOCOL (SCPS-FP)

CCSDS 717.0-B-1

BLUE BOOK

May 1999



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CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

AUTHORITY

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This document has been approved for publication by the Management Council of the Consultative Committee for Space Data Systems (CCSDS) and represents the consensus technical agreement of the participating CCSDS Member Agencies. The procedure for review and authorization of CCSDS Recommendations is detailed in reference [B1], and the record of Agency participation in the authorization of this document can be obtained from the CCSDS Secretariat at the address below.

This Recommendation is published and maintained by:

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CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

STATEMENT OF INTENT

The Consultative Committee for Space Data Systems (CCSDS) is an organization officially established by the management of member space Agencies. The Committee meets periodically to address data systems problems that are common to all participants, and to formulate sound technical solutions to these problems. Inasmuch as participation in the CCSDS is completely voluntary, the results of Committee actions are termed **Recommendations** and are not considered binding on any Agency.

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- o Whenever an Agency establishes a CCSDS-related **standard**, this **standard** will be in accord with the relevant **Recommendation**. Establishing such a **standard** does not preclude other provisions which an Agency may develop.
- o Whenever an Agency establishes a CCSDS-related **standard**, the Agency will provide other CCSDS member Agencies with the following information:
 - The **standard** itself.
 - The anticipated date of initial operational capability.
 - The anticipated duration of operational service.
- o Specific service arrangements shall be made via memoranda of agreement. Neither this **Recommendation** nor any ensuing **standard** is a substitute for a memorandum of agreement.

No later than five years from its date of issuance, this **Recommendation** will be reviewed by the CCSDS to determine whether it should: (1) remain in effect without change; (2) be changed to reflect the impact of new technologies, new requirements, or new directions; or, (3) be retired or canceled.

In those instances when a new version of a **Recommendation** is issued, existing CCSDS-related Agency standards and implementations are not negated or deemed to be non-CCSDS compatible. It is the responsibility of each Agency to determine when such standards or implementations are to be modified. Each Agency is, however, strongly encouraged to direct planning for its new standards and implementations towards the later version of the Recommendation.

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

FOREWORD

The Space Communications Protocol Specification (SCPS) File Protocol (SCPS-FP) provides End-to-End Application-Layer Services for flight missions in the space environment. It is based on Internet File Transfer Protocol (FTP) and is generally interoperable with it. It does, however, extend and modify FTP in order to meet the unique requirements of space flight operations. This document anticipates reader familiarity with FTP and, therefore, addresses only those capabilities that have been added to FTP.

Through the process of normal evolution, it is expected that expansion, deletion, or modification of this document may occur. This Recommendation is therefore subject to CCSDS document management and change control procedures as defined in reference [B1]. Current versions of CCSDS documents are maintained at the CCSDS Web site:

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Questions relating to the contents or status of this document should be addressed to the CCSDS Secretariat at the address indicated on page i.

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

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CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

DOCUMENT CONTROL

Document	Title	Date	Status
CCSDS 717.0-B-1	Space Communications Protocol Specification (SCPS)—File Protocol (SCPS-FP)	May 1999	Original issue

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

CONTENTS

<u>Section</u>	<u>Page</u>
1 INTRODUCTION	1-1
1.1 PURPOSE	1-1
1.2 SCOPE	1-1
1.3 APPLICABILITY	1-1
1.4 ORGANIZATION OF RECOMMENDATION	1-1
1.5 TERMINOLOGY	1-2
1.6 REFERENCES.....	1-2
2 OVERVIEW	2-1
3 TECHNICAL SPECIFICATION	3-1
3.1 INTERNET FTP	3-1
3.2 DATA TRANSFER FUNCTIONS	3-1
3.3 FILE TRANSFER FUNCTIONS.....	3-8
3.4 DECLARATIVE SPECIFICATIONS	3-15
3.5 STATE DIAGRAMS	3-21
3.6 CONNECTION ESTABLISHMENT	3-21
3.7 INTERFACE TO LOWER PROTOCOL STACK LAYERS.....	3-22
3.8 MISCELLANEOUS SCPS-FP REQUIREMENTS.....	3-22
4 MANAGEMENT INFORMATION BASE (MIB) REQUIREMENTS	4-1
4.1 OVERVIEW	4-1
4.2 DATA TRANSFER TYPE	4-1
4.3 TRANSMISSION MODE.....	4-1
4.4 DATA STRUCTURE	4-1
4.5 AUTORESTART.....	4-2
4.6 MAXIMUM NUMBER OF AUTOMATIC RESTARTS	4-2
4.7 USE PORT COMMAND ON EACH SEND.....	4-2
4.8 SUPPRESS SERVER REPLY TEXT	4-2
4.9 SERVER IDLE TIMEOUT.....	4-3
4.10 BEST EFFORT TRANSPORT SERVICE	4-3
4.11 BEST EFFORT TRANSPORT SERVICE FILL CHARACTER.....	4-3

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

CONTENTS (continued)

<u>Section</u>	<u>Page</u>
5 CONFORMANCE REQUIREMENTS.....	5-1
5.1 CONFORMANCE REQUIREMENTS OVERVIEW	5-1
5.2 SCPS-FP CONFORMING MINIMUM IMPLEMENTATION	5-1
5.3 SCPS CONFORMING FULL IMPLEMENTATION	5-3
5.4 FTP INTEROPERABLE IMPLEMENTATION	5-4
5.5 OTHER OPTIONAL IMPLEMENTATIONS.....	5-5
ANNEX A ACRONYMS AND ABBREVIATIONS	A-1
ANNEX B INFORMATIVE REFERENCES.....	B-1
ANNEX C SCPS-FP PROTOCOL IMPLEMENTATION CONFORMANCE	
STATEMENT PROFORMA	C-1
ANNEX D SCPS-FP SERVICE SPECIFICATION	D-1

Figure

3-1 State Diagram 1	3-21
3-2 State Diagram 2	3-21
D-1 State Diagram 1	D-4
D-2 State Diagram 2	D-5
D-3 State Diagram 3	D-6

Table

3-1 Rollback Algorithm without Autorestart.....	3-7
3-2 Rollback Algorithm with Autorestart.....	3-7
3-3 Transport Services Summary	3-22

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CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

1 INTRODUCTION

1.1 PURPOSE

The purpose of this Recommendation is to define the Space Communications Protocol Specification (SCPS) File Protocol (SCPS-FP). This definition will allow independent implementations of the SCPS-FP in the space and ground segments of the SCPS Network to interoperate.

1.2 SCOPE

This Recommendation addresses communications between space platforms and ground systems, and between space platforms. It is designed to support efficient file-transfer and file-operation requirements of current and upcoming space missions through extensions and modifications to Internet File Transfer Protocol (FTP).

1.3 APPLICABILITY

This Recommendation is applicable to space missions and ground systems that claim conformance to the SCPS-FP. It is intended that this Recommendation become a uniform standard for all active Member and Observer Agencies of the CCSDS.

1.4 ORGANIZATION OF RECOMMENDATION

This SCPS-FP Recommendation is organized as follows:

- Section 1 provides an introduction to the standard, introduces new protocol terminology, and documents the normative references.
- Section 2 provides an overview of the SCPS File Protocol.
- Section 3 documents the protocol specifications for a SCPS-FP.
- Section 4 documents the Management Information Base (MIB) requirements for SCPS-FP.
- Section 5 documents the conformance requirements for SCPS-FP.
- Annex A defines acronyms and abbreviations used in the document.
- Annex B lists informative references.
- Annex C contains the Protocol Implementation Conformance Statement (PICS) proforma for SCPS-FP.
- Annex D contains the Service Specification.

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

This Recommendation modifies and adds to Internet FTP. It makes normative reference to the Internet standards that define FTP (references [1] and [2]). It makes informative reference to other documents (see annex B).

1.5 TERMINOLOGY

The terminology as outlined in Internet Standard 9 (reference [1]), section 2.2, is applicable to the SCPS-FP with the following additions:

Cyclic Redundancy Check (CRC): A polynomial-based code used for protecting against recording and communications errors (see reference [B2]).

control data: A collection of the information necessary to control the operation of the record read and record update services. This information includes data such as the files to be read/updated, checksum, option flags, and update data.

network byte order: The order in which the bytes of a word are transmitted. For a 32-bit word, W1.W2.W3.W4, where W1 is the most significant octet, W1 is transmitted first, W2 next, then W3, and finally W4. The same applies for a 16-bit number, W1.W2, where W1 corresponds to the high 8 bits. W1 is sent first, and then W2.

rollback: Of or pertaining to the act of rolling back (undoing) incomplete changes made to a file for which the transfer or record operation terminated with errors and thereby restoring the file to its pre-transfer or pre-record operation state.

user-FP: Same as user-FTP in Internet Standard 9 (reference [1]). Terminology changed in SCPS-FP specification to remove direct reference to FTP.

server-FP: Same as server-FTP in Internet Standard 9 (reference [1]). Terminology changed in SCPS-FP specification to remove direct reference to FTP.

NVT-ASCII: The ASCII collation sequence.

1.6 REFERENCES

The following documents contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All documents are subject to revision, and users of this Recommendation are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS Recommendations.

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

- [1] J. Postel and J. Reynolds. *File Transfer Protocol*. STD 9, October 1985. [RFC 959][†]
- [2] R. Braden. *Hosts Requirements*. STD 3, October 1989. [RFC 1122, RFC 1123]
- [3] *Packet Telemetry*. Recommendation for Space Data System Standards, CCSDS 102.0-B-4. Blue Book. Issue 4. Washington, D.C.: CCSDS, November 1995.
- [4] *Space Communication Protocol Specification (SCPS)—Transport Protocol (SCPS-TP)*. Recommendation for Space Data System Standards, CCSDS 714.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, May 1999.

[†] Internet Request for Comments (RFC) texts are available on line in various locations (e.g., <http://ietf.org/rfc/>). In this list, Internet Standards are identified by 'STD' followed by the number of the standard, and RFCs are identified by 'RFC' followed by the number of the RFC. RFCs comprised by Internet Standards are given in square brackets following the citation.

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CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

2 OVERVIEW

The extensions to FTP and its augmentations as contained in Internet Standards 9 and 3 (references [1] and [2]) are necessitated by technical requirements for transfers of and operations on files and analogous delimited data sets in the space communications environment. These technical requirements include

- transfers of command and data files to spacecraft;
- transfers of application software to spacecraft;
- transfers of science or mission data to ground without special level-zero processing;
- limited management of files onboard spacecraft (delete, rename, and directory services);
- automatic restart of transfers after an interruption;
- reading of portions of files resident on board spacecraft; and
- updates/changes to files on board spacecraft.

The SCPS-TP protocol is characterized by a command/reply dialog on a stream connection. The client Protocol Interpreter (PI) accepts input from the user, translates user commands to server commands, and issues the server commands on the control connection. The server PI parses those commands, looks up commands in a table, and transfers control to the routine associated with the command. This specification defines procedures for each PI to execute upon success or failure of commands. When a command has been parsed and processed, either successfully or unsuccessfully, the server issues a reply message on the control connection. Commands and replies are short ASCII strings terminated with the ASCII control sequence <CRLF>.

SCPS-FP is based on Internet FTP, which is described in references [1] and [2]. SCPS-FP maintains interoperability with Internet FTP on the control connection. This Recommendation is designed to be scaleable to fit onto the most resource-constrained service and yet expandable to full Internet compatibility according to mission requirements.

SCPS-FP is a profile of Internet FTP that adds capabilities to the Internet standard as follows:

- automatic restart of a failed transfer;
- read, write, add, change, and delete individual file records;
- interrupt (pause) a file transfer so that it can be restarted later from the interrupt point;
- suppress reply text to improve bandwidth efficiency;
- assure file and record integrity in the case of abnormal connection loss.

These capabilities are designed to yield efficient transfer of file-oriented data sets across the space link.

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CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

3 TECHNICAL SPECIFICATION

3.1 INTERNET FTP

SCPS-FP adopts the File Transfer Protocol (FTP) as specified in Internet Standards 9 and 3 (references [1] and [2]), with the modifications and extensions specified in section 3 of this document.

3.2 DATA TRANSFER FUNCTIONS

3.2.1 DATA REPRESENTATION AND STORAGE

3.2.1.1 Data Types

3.2.1.1.1 General

The non-print format controls are applicable to SCPS-FP. EBCDIC and Local data types may be supported as additional, non-SCPS capabilities.

3.2.1.1.2 ASCII Type

The ASCII data type is optional for SCPS-FP file transfer operations; it does not apply to SCPS-FP record operations. The ASCII type is not the SCPS-FP default.

3.2.1.1.3 Image Type

The IMAGE data type is the default for SCPS-FP and must be supported by all SCPS-FP implementations.

3.2.1.2 Data Connection Management

The SCPS-FP user-PI must initiate the use of non-default ports because of the need for SCPS-FP to hold the connection record for a timeout period to guarantee reliable communication.

3.2.1.3 Stream Mode

If the structure is a file structure, the EOF is indicated by the sending host's closing of the data connection, in which case all bytes are data bytes.

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

3.2.1.4 CCSDS Packets

If the structure is a record structure, indicating the file consists of contiguous CCSDS Packets, the following provisions are required to enable use of FP restart and record read/update capabilities.

- a) the FP shall issue the STRU command with the Record argument (ASCII character 'R');
- b) the FP shall issue the TYPE command if necessary to switch to IMAGE data type before transferring files of CCSDS Packets;
- c) the FP shall invoke the record boundary option of SCPS-TP (reference [4]) to delimit records during transfer;
- d) in record operations, record identifiers shall be interpreted as referring to the Packet Sequence Count field in the record;
- e) the protocol shall use the Packet Data Length field to delimit records in the file.

3.2.2 ERROR RECOVERY AND RESTART**3.2.2.1 Stream Mode Restart with IMAGE Data Type**

3.2.2.1.1 When a system failure is detected, the receiving Data Transfer Process (DTP) shall determine the restart marker by querying the file system for the current size of the file.

3.2.2.1.2 Restart markers shall not be imbedded in the data in stream mode.

3.2.2.1.3 There are three cases in which SCPS-FP restart may be accomplished in stream mode:

- a) user-to-server transfer (e.g., STOR):
 - 1) the user-FP shall send 'SIZE pathname' to the receiving server-FP;
 - 2) the server-FP shall send '213 pathname SIZE rrrr' to the user-FP, where rrrr is the size of the file (indicated by pathname) stored locally at the server;
 - 3) to restart the transfer, the user-FP shall reposition its local file system using restart marker rrrr and send the command 'REST rrrr' to the server-FP;
 - 4) the server-FP shall save restart marker rrrr for restart;
- b) server-to-user transfer (e.g., RETR):
 - 1) the user-FP shall determine the size (rrrr) of the file as stored by the local file system;

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

- 2) to restart the transfer, the user-FP shall reposition its local file system using restart marker rrrr and send the command 'REST rrrr' to the server-FP;
- 3) the server-FP shall save restart marker rrrr for restart;
- c) server-to-server ('third-party') transfer (e.g., PROXY):
 - 1) the user-FP shall send 'SIZE pathname' to the receiving server-FP;
 - 2) the receiving server-FP shall send '213 pathname SIZE rrrr' to the user-FP, where rrrr is the size of the file (indicated by pathname) stored locally at the receiving server;
 - 3) to restart the transfer, the user-FP shall
 - send the command 'REST rrrr' to the receiving server-FP;
 - send 'REST ssss' to the sending server-FP, where ssss = rrrr;
 - 4) each server shall save the received restart markers for restart.

3.2.2.1.4 Immediately after sending the REST command, the user-FP shall send the file transfer command (such as RETR, STOR or LIST) that was being executed when the system failure occurred.

3.2.2.1.5 Before the actual data transfer resumes, the server-FP process for the file transfer command shall advance the file to the restart marker.

3.2.2.1.6 The automatic and manual restart of a CCSDS Packet file transfer (RETR or STOR of files having the CCSDS Packet structure) shall follow the processing documented in 3.2.2.2 and 3.2.2.4 with the following additional provisions:

- a) restart must be on the CCSDS Packet boundary for transfers of files having the CCSDS Packet structure;
- b) the restart marker shall be the Packet Sequence Count of the last complete Packet received.

NOTE – General provisions for operations involving the CCSDS Packet structure are given in 3.2.1.4.

3.2.2.2 Stream Mode Restart with ASCII Data Type

When the data type is ASCII, the restart point is always relative to the start of the transfer image, not the flat file size in the file system. All other processing is the same as with the IMAGE data type.

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

3.2.2.3 Automatic Restart

3.2.2.3.1 For SCPS-FP restart cases, the user Protocol Interpreter (user-PI), rather than the user-FP, shall be responsible for the decision making for

- reestablishing connections,
- re-logging in the user,
- sending the SIZE and/or REST commands,
- interpreting and responding to the replies for these commands, and
- resending the original file transfer command (e.g., RETR, STOR, LIST) to reinitiate the file transfer.

3.2.2.3.2 To use the autorestart capability, the user-FP and the server-FP must both be in autorestart mode:

- a) the autorestart protocol command (ARST) shall be used to enable autorestart at the server-FP;
- b) the no-autorestart protocol command (NARS) shall be used to disable autorestart at the server-FP.

NOTE - As documented in 3.3.2, the ARST command indicates to the server that the client is in autorestart mode and therefore file changes should not be rolled back when an error occurs (otherwise a partial file that has been transferred will be wiped out). Partial files are saved if the data connection aborts or times out. Conversely, the NARS command indicates to the server that the client is not in autorestart mode and that therefore it should roll back changes when the data connection aborts or times out.

3.2.2.3.3 When autorestart is enabled by the user, the user-PI shall restart a failed data transfer (without requiring the user to specify the restart point or command to restart) up to the maximum number of restarts specified in the MIB parameter fpMaxAutorestarts (see 4.6):

- a) the maximum number of restarts shall be set to 3 as a default;
- b) the user-FP may notify the user of the failed transfer and request confirmation to continue with the restart.

NOTE – User notification may be useful in situations where an automatic restart does not make sense (e.g., spacecraft is out of view).

3.2.2.3.4 Autorestart of a failed transfer in stream mode shall proceed as detailed in 3.2.2.1.

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

3.2.2.3.5 In cases where the control connection had to be reestablished in order to proceed with the autorestart, any transfer parameters that were set by the user prior to the start of the file transfer should be resent to the server to ensure that the state of the transfer parameters at the server is correct.

NOTE – Block and compressed modes are not required for SCPS-FP. These modes are not universally interoperable. Error recovery and restart for block and compressed modes for SCPS-FP are as described in reference [1], section 3.5, with the added feature that the user-PI can, if enabled, initiate the restart automatically.

3.2.2.4 Manual Interrupt and Manual Restart

NOTE – Manual interrupt provides the capability for the user-FP to stop a file transfer temporarily and then restart it at a later time.

3.2.2.4.1 There are three cases for SCPS-FP interrupt in all modes.

a) user-to-server transfer:

- 1) the user-FP shall send 'INTR' to the server-FP;
- 2) in response, the server-FP shall stop the file transfer and send '256 Transfer Interrupted at rrrr' to the user-FP, where rrrr is the size of the file stored locally at the server;
- 3) the user-FP shall save the restart marker rrrr for restart;
- 4) the user-FP may reinitiate the transfer process by repositioning its local file system using restart marker rrrr and sending 'REST rrrr' to the server-FP;

b) server-to-user transfer:

- 1) the user-FP shall send 'INTR' to the server-FP;
- 2) the server-FP shall stop the file transfer and send '256 Transfer Interrupted at ssss' to the user-FP;
- 3) the user-FP shall ignore the restart marker specified in the INTR reply;
- 4) the user-FP may reinitiate the transfer process by sending 'REST rrrr' to the server-FP, where rrrr is the amount of data received and stored successfully at the user site;

c) server-to-server ('third-party') transfer:

- 1) the user-FP shall send 'INTR' to the sending server-FP;

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

- 2) the sending server-FP shall stop the file transmission and send '256 Transfer Interrupted at ssss' to the user-FP;
- 3) the user-FP shall send 'INTR' to the receiving server-FP:
 - the user-FP should wait for the sending server-FP to respond with the 256 reply before sending 'INTR' to the receiving server-FP;
 - if the sending server-FP responds with a code other than 256 (e.g., 226 - file transfer was completed before interrupt received), then the file transfer should continue as it normally would in response to the received reply code;
- 4) in response to 'INTR', the receiving server-FP shall stop the file transfer process and send '256 Transfer Interrupted at rrrr' to the user-FP;
- 5) the user-FP shall ignore the restart marker in the sending server-FP's reply and use the restart marker in the receiving server-FP's reply when issuing the REST command;
- 6) the user-FP may reinitiate the transfer process by sending 'REST rrrr' to the receiving server-FP and sending server-FP.

3.2.2.4.2 To restart the interrupted file transfer, the user-FP shall follow the restart procedures outlined in 3.2.2.1.

3.2.3 INTEGRITY

3.2.3.1 File Transfer Integrity

3.2.3.1.1 The user-FP and server-FP shall roll back any incomplete changes made to a file during a non-autorestart RETR or STOR operation that has terminated with errors, thereby restoring the affected file to its pre-transfer state.

3.2.3.1.2 At the start of a transfer, if the destination filename is in use, FP renames that file using a temporary name.

3.2.3.1.3 The rollback algorithm used shall be as detailed in table 3-1 when autorestart is disabled.

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

Table 3-1: Rollback Algorithm without Autorestart

Destination file existed at start of transfer	Reason for transfer abort	Action by FP
No	ABOR command	Delete partial file
No	INTR command	Keep partial file
No	time-out	Delete partial file
Yes	ABOR command	Restore original file, delete partial file
Yes	INTR command	Keep partial file, delete original file
Yes	time-out	Restore original file, delete partial file

3.2.3.1.4 In autorestart mode, when a transfer aborts because of a timeout, the FP actions shall be as detailed in table 3-2.

Table 3-2: Rollback Algorithm with Autorestart

Destination file existed at start of transfer	Reason for transfer abort	Action by FP
No	time-out	Keep partial file
Yes	time-out	Keep partial file, delete original file

3.2.3.2 Record Data Integrity

3.2.3.2.1 The user-FP and server-FP shall roll back any incomplete changes made to a file during a READ or UPDT operation that has terminated with errors, thereby restoring the affected file to its pre-record operation state.

3.2.3.2.2 To provide a secondary measure of integrity to ensure that a user does not update the wrong file inadvertently, the user-FP and server-FP shall employ the following CRC for the record update service to ensure the data integrity of the accessed files:

- a) The encoding shall be defined by the generating polynomial

$$G(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$$

- b) Mathematically, the CRC value corresponding to a given file shall be defined by the following procedure.

- 1) The n bits in the file are considered to be the coefficients of a mod-2 polynomial $M(x)$ of degree $n-1$. Bit 0 of the first octet corresponds to the $x^{(n-1)}$ term. Bit 7 of the first octet corresponds to the $x^{(n-8)}$ term. Bit 0 of the second octet corresponds to the $x^{(n-9)}$ term. Bit 7 of the second octet corresponds to the $x^{(n-16)}$ term, and so

CCSDS RECOMMENDATION FOR SCPS FILE PROTOCOL (SCPS-FP)

on. Bit 7 of the last octet corresponds to the least significant bit in $M(x)$. The last octet may need to be padded with zero bits to achieve an integral number of octets.

- 2) $M(x)$ is divided by $G(x)$ using mod-2 division, producing a remainder $R(x)$ of degree ≤ 31 . This mod-2 division is accomplished using the exclusive OR (XOR) operation for subtractions.
- 3) The coefficients of $G(x)$ and $R(x)$ are considered to be 32-bit sequences.
- 4) The bit sequence is complemented and the result is the CRC.

3.2.3.3 Files of CCSDS Packets

The rollback and CRC procedures for files of contiguous CCSDS Packets are as described in 3.2.3.1 and 3.2.3.2.

NOTE – General provisions for operations involving the CCSDS Packet structure are given in 3.2.1.4.

3.3 FILE TRANSFER FUNCTIONS

3.3.1 ACCESS CONTROL COMMANDS

Processing for the following access commands for SCPS-FP is as described in section 4.1.1 of Internet Standard 9 (reference [1]):

USER, PASS, CWD, ACCT, CDUP, QUIT.

3.3.2 TRANSFER PARAMETER COMMANDS

3.3.2.1 Processing for the following transfer parameter commands for SCPS-FP is as described in section 4.1.2 of Internet Standard 9 (reference [1]):

MODE, PORT, PASV, TYPE, STRU.

3.3.2.2 The additional SCPS-FP commands are:

a) ENABLE AUTORESTART (ARST):

- The ARST command shall cause the server-FP to set the MIB parameter `fpAutorestartEnabled` to 'TRUE' (enabled).
- While autorestart is enabled, partial files shall not be rolled back when an error occurs.